

## OPA660 DRIVES MAGNETIC RECORDING HEAD

By Jeff Huehn

The OPA660 is a unique solution to many high-speed design problems. It offers the high-speed and wide-bandwidth of discrete transistors necessary for RF, IF, and video circuitry while maintaining the simplicity, reliability, and ease-of-use of a monolithic, integrated circuit. For applications where neither an op amp nor a discrete transistor quite fit, the OPA660 may be exactly what you're looking for.

The OPA660 consists of two distinct building blocks, a buffer and an Operational Transconductance Amplifier (OTA), that can be used independently or in combination to achieve a variety of amplification stages. Quiescent current for both blocks is set using an external resistor allowing the user to program quiescent current depending on performance needs. This resistor is omitted from the drawings for clarity but is required for proper operation. The voltage buffer is an open-loop buffer with a gain slightly less than unity and is ideal for interstage buffering. The OTA is a

voltage controlled current source much like a bipolar transistor with the very important difference that the sense of the output current of the OTA is non-inverting. The B input is a high impedance input similar to the base, the E input is a low impedance input (or output in an E-follower configuration) similar to an emitter and C is an output whose current follows the equation:

$$I_C = g_M (V_B - V_E)$$

The OTA can be used in most familiar transistor configurations such as those shown in Figure 1, but remember that there is no inversion between input voltage and output current. The most commonly used is the Common-E amplifier. Gains up to 20V/V can be achieved. There are two phenomena that limit bandwidth in this configuration. The first is a capacitance that increases with the transconductance and reacts with the input impedance. This dominates when  $g_M$  is large. The second is a lowpass filter created by the

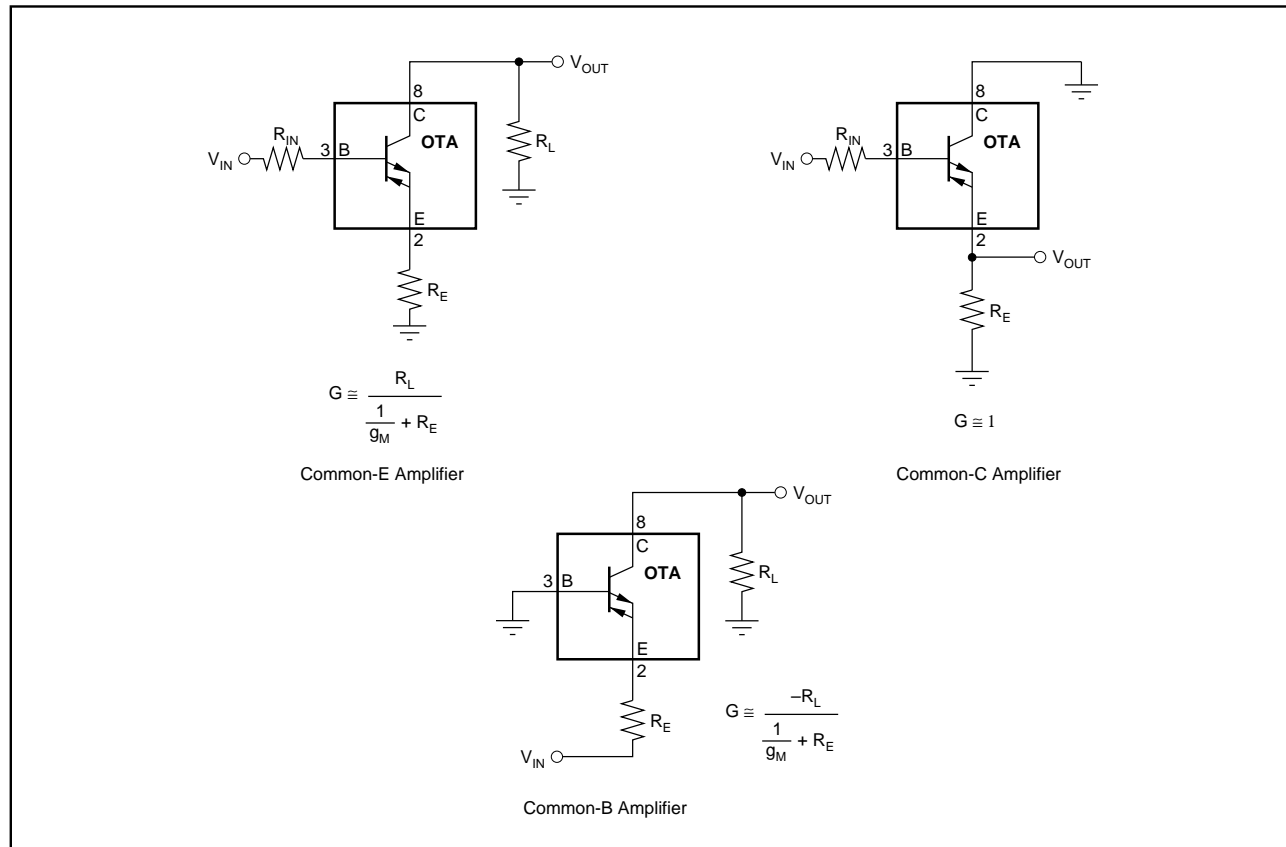


FIGURE 1. OTA Configurations.

OTA output capacitance and the load resistor. The end result is that generally, for lower gains ( $G = 1$  or  $2$ ) bandwidth is optimized with about  $50\Omega$  from the E terminal to ground while for higher gains ( $G > 2V/V$ ) bandwidth is optimized by using an  $R_E$  of  $10\Omega$ .

The Common-C configuration provides an emitter-follower style buffer identical to the buffer block except that load current will be replicated in the C output. Because of the sense of the C output current, it can be connected to the E terminal to increase the output drive current. The Common-B configuration provides an inverting gain with a low impedance input. Use of the buffer as a high impedance input connected by a series resistor to the E input of the OTA results in a transconductance amp with differential high impedance inputs (shown in Figure 1).

One application that takes advantage of this type of amplifier is a push-pull complementary current source useful for

driving bridges or, in the example of Figure 2, a magnetic recording head. The differential input is represented by  $IN$  and  $\overline{IN}$ . Each OPA660 is connected as an OTA with  $220\Omega$  in series with each input to insure stability. A  $470\Omega$  resistor from pin 1 to  $-5V$  sets the quiescent current at approximately  $20mA$ . The  $50\Omega$  resistor sets the transconductance of the device. Two OPA660s are connected in parallel (to increase drive current) on either side of the recording head so that as the top two devices are sourcing the bottom devices are sinking resulting in a bipolar, bi-directional current through the head. The wide voltage compliance range alleviates potential problems caused by output current mismatches, but carefully matched resistors (1% tolerance) should be used to minimize variations in  $g_M$ .

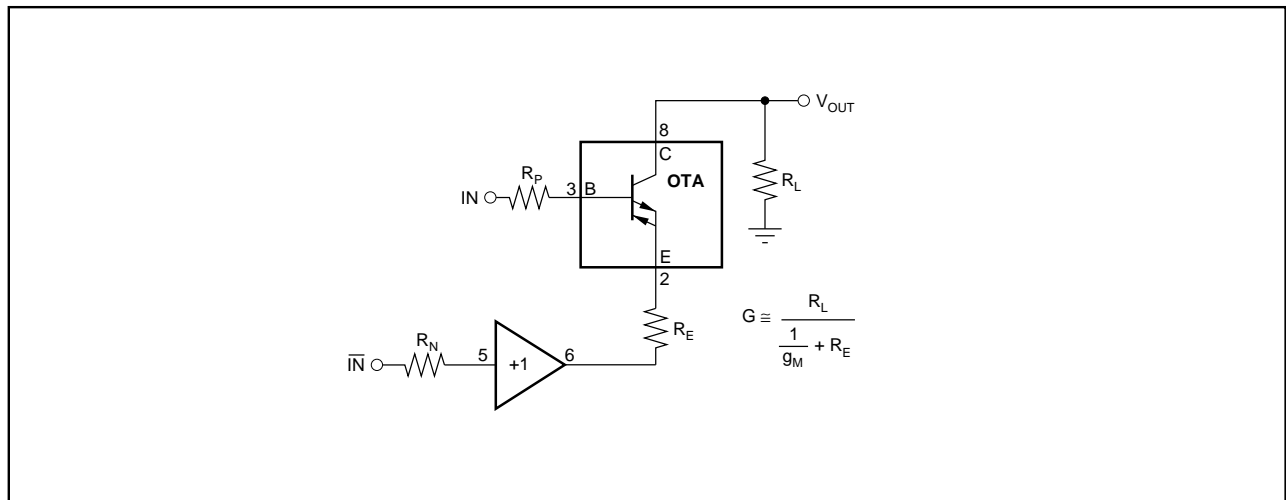


FIGURE 2. Differential Transconductance Amplifier.

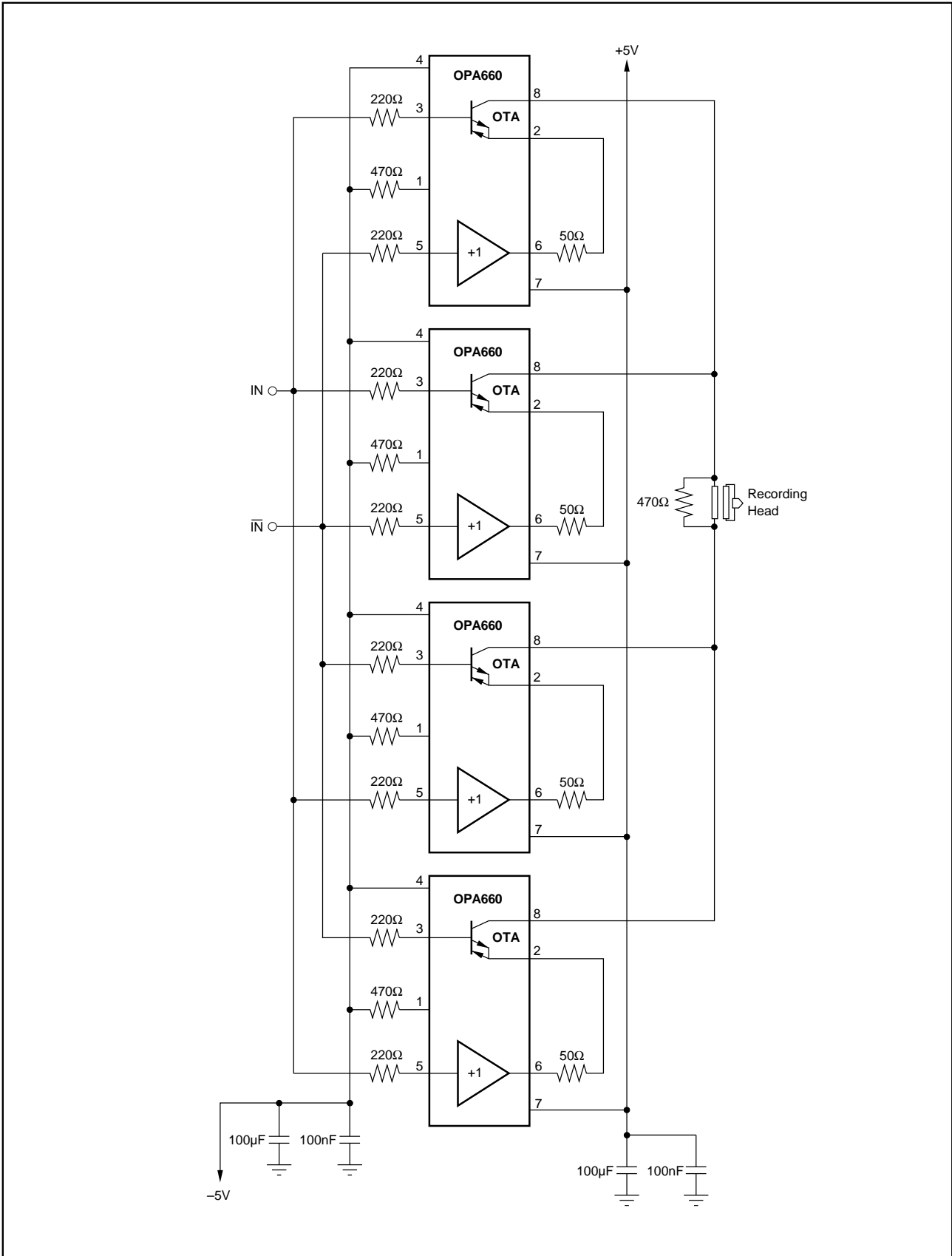


FIGURE 3. Recording Head Driver Circuit.